



Reforestation of Austin's Parks and Riparian Zones
Project Design Document – Year 6

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INSTRUCTIONS

Project Operators must complete and submit this Project Design Document (PDD) to request credits after the fifth anniversary of the Credit Commencement Date. City Forest Credits then reviews this PDD as part of the validation process along with all other required project documents. An approved third-party verifier then does an independent check of all documents and compliance with the Protocol, known as verification. An updated PDD will need to be submitted for future verification after Year 25.

Project Operators should enter data and supporting attachments starting on page 3 under Project Overview where you find “[Enter text here]” as thoroughly as possible and provide numbered attachments for maps and other documentation (ex: 1 – Regional Map). Keep all instructions in the document.

Below is a list of documents that are needed to complete a successful Year 6 Project Design Document:

For the Single Tree Planting Design:

- Carbon Quantification Year 6 Credit tool
- Tree Sampling Data
- Geocoded photos
- Project geospatial data, if there have been changes (KML file or shapefile)

For the Cluster Planting Design

- Project Area imaging from any telemetry, imaging, or remote sensing service
- i-Tree Canopy report
- i-Tree Canopy source data
- Project geospatial data, if there have been changes (KML file or shapefile)
- Carbon Quantification Year 6 Credit tool

For the Area Reforestation Planting Design (previously Canopy Design):

- Either:
 - Project Area imaging from any telemetry, imaging, or remote sensing service
 - i-Tree Canopy report
 - i-Tree Canopy source data
- Or:
 - Tree plot sampling data
- Project geospatial data, if there have been changes (KML file or shapefile)
- Carbon Quantification Year 6 Credit tool
- Summary of approach to quantifying the local CO₂ index

PROJECT OVERVIEW

Project Name: Reforesting Austin’s Parks and Riparian Zones

Project Number: 002

Project Type: Planting Project (under the City Forest Credits Tree Planting Protocol - Version 6, August 11th, 2018)

Project Start Date: March 31st, 2018

Project Location: Austin, Texas

Project Operator Name: TreeFolks

Project Operator Contact Information: Valerie Tamburri, valerie@treefolks.org, 512-443-5323

PROJECT AND PLANTING DESIGN UPDATES

Include information on changes to the project including tree survival, ownership, or other relevant updates.

TreeFolks planted 47 trees at two sites, Davis-White Park (32 trees) and Patterson Park (15 trees) in the City of Austin in March of 2018 using the Single Tree Approach. TreeFolks also planted 1,250 trees in 2018 at a third City of Austin site, Onion Creek, using the Area Reforestation Planting Design.

Site Name	Site #	Travis Co. Parcel ID	Planting Method	# of Trees	# of Acres
Onion Creek	1	345876	Area Reforestation	1250	3.85
Davis-White Park	2	217436	Single Tree	32	-
Patterson Park	3	211887	Single Tree	15	-

There have been no changes in ownership on any of the project sites. Site 1 is located on a land parcel that remains under the ownership of the Austin Watershed Department, and Sites 2 & 3 are both located on land parcels owned by the Austin Parks and Recreation Department (PARC). Friends of Patterson Park is providing tree maintenance at Patterson Park, while PARC watering trucks are providing tree maintenance at Davis White. There are no plans for maintenance at Onion Creek aside from the cessation of all mowing.

Single Tree- Davis-White & Patterson Park Plantings

Since 2018, TreeFolks and the City of Austin have replaced three trees with new species after the original trees planted at that site died.

- Tree ID# PAT-1 which was originally *Quercus macrocarpa* was replaced with *Eysenhardtia texana* sometime between March 2018 and May 2019.
- Tree ID# PAT 2 which was originally *Quercus polymorpha* was replaced with *Acacia farnesiana* sometime between November 2021 and May 2022. This replacement was then recorded as having died as well sometime between October 3rd, 2022 and July 7th, 2023.

- Tree ID# PAT-12 which was originally *Sophora secundiflora* was replaced with *Continus obovatus* between August 2020 and November 2021. This replacement was then recorded as having died as well sometime before May 16th, 2023.

The rest of this Year 6 Project Design Document will be referring to the status of the replacement trees when assessing the status of the 47 planting sites, not the originally planted trees.

The Year 4 Verification sampling recorded the loss of 8 of the 47 trees (17%) on or before October 3rd, 2022. The Year 6 Verification sampling (conducted on July 6th, 2023) recorded the loss of two additional trees (PAT-10 and the replacement tree for PAT-2). This brings the total number for tree losses to 10 out of 47 (21.3%). At this time none of the 10 dead trees have been replaced and there is currently no plan to do so. Three of the dead trees were classified as broadleaf deciduous large (BDL), five were classified as broadleaf deciduous small (BDS), one was broadleaf evergreen medium (BEM) and one was broadleaf evergreen small (BES).

Two major events could have resulted in these tree mortalities:

- Severe Winter Storm Uri, which lasted from February 13th through February 17th, 2021, bringing with it an all-time low of 6° F (-14.4° C) for Austin, and a total of 144 hours of below-freezing temperatures.
- Drought conditions across Texas throughout 2022 and 2023. From 5/17/2022 - 4/25/2023 and 6/13/2023 through the time of the writing of this report (September 7th, 2023) over 50% of Travis county was registered by the U.S. Drought Monitor to be under some kind of drought condition (D1, moderate drought - D4, exceptional drought), with the time periods of 7/19/22 - 8/23/22 and 07/24/23 through the time of the writing of this report (September 7th, 2023) designating over 50% of the county as experiencing either exceptional (D5) or extreme (D4) drought.

Canopy - Onion Creek Planting

During the Year 4 verification report (2022) it was decided that the Project Area should be reduced from 4.30 acres to 3.85 acres based on the presence of older canopy within the originally described project extent. As of August 24th, 2023 there have been no recorded major die-off events or tree survival issues at this site. Following iTree sampling protocols, percent tree cover was assessed as comprising 55.00% % of the total land cover of the project area on June 6, 2023, compared to 37.54% reported during sampling conducted for the Year 4 verification report (a 17.46% difference).

CARBON QUANTIFICATION DOCUMENTATION (Section 9 and Appendix B)

Describe and summarize the planting design, sampling, and appropriate quantification/measurement method for the project – Single Tree, Clustered, or Area Reforestation. Include the project’s climate zone and method of data collection. Outline the estimated total number of credits to be issued to the project over 25 years as well as the amount to be issued upon successful validation and verification in Year 6. Attach the quantification tool and appropriate sampling tool.

List of quantification Tools by planting method (CFC to provide guidance and resources):

- 1) *Single Tree – single tree quantification tool*
- 2) *Clustered – cluster quantification tool*
- 3) *Area Reforestation – quantification with CO₂ calculated per acre*

To ensure performance of the credits, Project Operators must commit to the following at Year 6, with additional requirements after Year 25 based on the appropriate quantification method.

1) *Single Tree*

- a. *Year 6: Project Operators must generate a random sample of project tree sites using the Single Tree Quantification Tool. Project Operators must visit those sampled tree sites and collect data on whether the sample contains a live tree, standing dead tree, or no tree. Provide geocoded photos or imaging of a minimum sample of 20% of the trees. The tracking file includes a column where each tree is assigned a unique serial number to help with tracking each coordinate and tree picture or image.*
 - i. *Based on this data, the number and species of project trees is adjusted and a new CO₂ projected amount by after Year 25 is generated.*

2) *Clustered*

- a. *Year 6: Project Operators provide images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres). Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging. Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. I-Tree Canopy will supply you with the standard errors. If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.*
 - i. *If the canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy) is 11.5% of an acre), then the credits projected in the Clustered Quantification Tool may be issued. If canopy coverage is below 11.5%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 11.5%.*

3) *Area Reforestation (formerly Canopy planting design)*

- a. *Year 6: Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 6.*
 - i. *If the canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56square feet per tree (4-foot diameter of canopy) is 11.5% of an acre), then the credits projected in the Quantification Tool may be issued. If canopy coverage is below 11.5%, then the number of credits issued is reduced by the same percentage as the canopy coverage falls below 11.5%.*

Single Tree (Davis-White Park & Patterson Park Plantings)

Overview - Single Tree (Davis-White Park & Patterson Park Plantings)

In March 2018, TreeFolks planted 32 trees in Davis-White Park and 15 trees in Patterson Park (47 total) in partnership with Friends of Patterson Park and other volunteer groups. Sixteen different species of trees were planted between the two parks, the most common being *Cercis canadensis* (Texas Redbud), *Platanus mexicana* (Mexican sycamore), *Chilopsis linearis* (Desert Willow), *Carya illinoensis* (Pecan), and *Ulmus crassifolia* (Cedar Elm), in that order. TreeFolks used the single-tree planting design and quantification method for this planting. All trees were planted more than fifteen feet apart on-center.

Data Collection - Single Tree (Davis-White Park & Patterson Park Plantings)

All planting sites were assessed for tree status (Alive, Vacant, or Dead Standing) and findings were recorded in the Single Tree Year 6 Credit Tool. As of sampling on July 6th, 2023, thirty-seven of the forty-seven trees planted are alive and ten are either dead or vacant and have not been replaced. This is two additional tree mortalities compared to the findings of the Year 4 report (sampling conducted on October 3rd, 2022).

The Observed Mortality Rate is therefore 21.3%. As per registry guidance, since the observed mortality rate at Year 4 exceeds the 20% anticipated mortality deduction used at the initial crediting to forecast CO2 storage over 25 years, the Observed Mortality rate was used to recalculate carbon storage at Year 6. In order to account for differing survival rates between tree types, mortality percentages for each were calculated and used to recalculate carbon storage. Since more trees of a smaller stature died than those of a larger stature (e.g. 31% of BDS vs. 14% of BDL) and actual observed mortality was used in calculations instead of a standard 20% mortality rate across all tree types, the total number of credits to be issued actually increased slightly from the 102 credits described in the Year 4 report to 106 credits. As stated above in the project and planting design updates, it is likely that these mortalities can be attributed to either severe winter storm Uri or the 2022-2023 Central Texas drought conditions.

Additionally, geocoded photos of all planting sites were included in documentation as a ZIP file attachment. These photos were also mapped onto a KML file, which is included as an attachment as well. There have been no changes to the recorded location of any of the planting sites, so no updated shapefile will be attached to this year 6 verification.

Attachments: 1 PJ002 SingleTree_CreditTool_Yr6.xlsx
2 PJ002 SingleTree_GeocodedPhotos_Yr6.zip
3 PJ002 SingleTree_PhotoMap_Yr6.kml

Carbon Quantification – Single Tree (Davis-White Park & Patterson Park Plantings)

Total number of trees planted	47
Project area (acres), if applicable	N/A
Total number of trees per acre, if applicable	N/A
Credits attributed to the project (tCO2e)	134

Credits after mortality deduction (21% mortality)	112
Contribution to Registry Reversal Pool Account (5%) (tCO ₂ e)	6
Total credits to be issued to the Project Operator (tCO₂e)	106
Total credits requested to be issued at Year 6	32

GHG Assertion – Single Tree (Davis-White Park & Patterson Park Plantings):

Project Operator asserts that the Project results in GHG emissions mitigation of 106 tons CO₂e over the 25-year Project Duration. Per Protocol guidelines, 30% of the Project GHG emissions mitigation is issued at Year 6, or 32 tons CO₂e at Year 6.

Following Year 4 monitoring the project’s total GHG emissions mitigation was revised to 102 credits from the 103 credits projected during initial crediting. The revised quantification was due to the species change of the three replacement trees compared to the original trees planted. Two trees classified as BDL were replaced by two trees classified as BDS, and one tree classified as BES was replaced by a tree classified as BDS.

Since the observed mortality rate for the year 6 verification was recorded as 21.3% (10 out of 47 trees), exceeding the 20% anticipated mortality rate, carbon storage was recalculated using the observed percentage. Taking into account the differing observed mortality rates between tree types, the total number of credits to be issued actually increased slightly from the 102 credits described in the Year 4 report to 106 credits.

The updated Projected CO₂ stored and credit issuance over 26 years is outlined below:

Single Tree Plantings	Projection at Initial Crediting	Updated Projection at Year 4	Updated Projection at Year 6
Total credits issued at Initial Crediting (10% CO ₂ (t))	10	10	10
Total credits issued at Year 4 (40% CO ₂ (t))	41	41	41
Total credits to be issued at Year 6 (30% CO ₂ (t))	31	31	32
Total credits to be issued at Year 26 (20% CO ₂ (t))	21	20	23
Total credits to be issued (tCO₂e)	103	102	106

Attachment: 1 PJ002 SingleTree_CreditTool_Yr6.xlsx

Area Reforestation (Onion Creek Riparian Canopy Planting)

Overview - Area Reforestation (Onion Creek Riparian Canopy Planting)

In January 2018, 1,250 trees were planted in Onion Creek using the area reforestation (previously canopy) planting design and quantification method. During the initial planting, the project area was originally recorded as 4.3 acres, resulting in a calculated tree density of 291 trees per acre. The objective of this project was to create full canopy regeneration through a combination of surviving trees and natural regeneration. The most commonly planted trees were *Sophora secundiflora* (Texas mountain laurel), *Fragula caroliniana* (Carolina buckthorn), *Senegalia berlandeieri* (formerly known as *Acacia berlandieri*, or Guajillo), and *Vachellis farnesiana* (formerly known as *Acacia farnesiana*, or Huisache).

During the Year 4 verification the project area boundary was adjusted from 4.30 acres to 3.85 acres to exclude large sections of pre-existing canopy that were included within the defined planting area. Since it is unlikely that the original volunteer crew planted any saplings under these older trees, the total number of trees planted within the reduced project area is likely the original 1,250 trees reported as having been planted. This would result in a recalculated tree density of 324 trees per acre.

Data Collection - Area Reforestation (Onion Creek Riparian Canopy Planting)

To analyze tree growth in the project area, random point sampling was used to estimate percent canopy cover. Random sampling point locations were generated via the Create Random Points tool in ArcGIS Pro, consistent with the i-Tree Canopy methodology. High-resolution leaf-on imagery for Year 6 (dated 6/6/2023) was acquired using the Upstream Tech Lens platform. Imagery was streamed to ArcGIS Pro and sampling points were overlaid and manually classified as belonging to one of two class types: Tree or Non-Tree. After assigning classes to 300 randomly selected points it was found that there was 55% tree cover and 45% non-tree cover with a standard error of (±2.86%). This is an increase of 17.46% in tree cover compared to what was found during the year 4 sampling (conducted on December 13th, 2022), which was a tree cover of 37.54% (±2.88%). Percent tree and non-tree, as well as standard error, for Year 6 were calculated according to the formulas used by i-Tree Canopy. Compared to the baseline canopy of 23.92%, measured at Year 4, new growth canopy was 31.08%, which meets the 11.5% threshold requirement for Year 6.

No changes in the project area have occurred since the 0.45-acre deduction made during the year 4 report. However, to be consistent with current Protocol practice, per Registry guidance the credit issuance was adjusted down to account for the 23.92% of pre-existing canopy measured at Year 4.

- Attachments: 4 PJ002 iTreeCanopyCalculator-Lens_DataPoints_Yr6.xlsx
- 5 PJ002 iTree Canopy Formula References
- 6-iTree_Yr6_SamplingImage-PJ002_Yr6.jpg

Carbon Quantification – Area Reforestation (Onion Creek Riparian Canopy Planting)

	Initial Crediting	Year 4 Projection (after adjusting Project Area)	Year 6 Projection
Total number of trees planted	1250	1250	1250

Project area (acres), if applicable	4.30	3.85	3.85
Total number of trees per acre, if applicable	291	324	324
Baseline tree canopy			23.92%
Credits attributed to the project, adjusted for baseline tree canopy (tCO ₂ e)	459	411	313
Credits after mortality deduction (N/A for area reforestation)	N/A	N/A	N/A
Contribution to Registry Reversal Pool Account (5%) (tCO ₂ e)	23	21	16
Total credits to be issued to the Project Operator (tCO₂e)	436	390	297
Total credits requested to be issued at Year 6	131	117	58

GHG Assertion – Area Reforestation (Onion Creek Riparian Canopy Planting):

Project Operator asserts that the Project results in GHG emissions mitigation of 297 tons CO₂e over the 25-year Project Duration. Per Protocol guidelines, 30% of the Project GHG emissions mitigation is issued at Year 6, or 89 tons CO₂e. However, given the credit amounts that have already been issued at Years 0 and 4, the issuance is adjusted to 58 credits.

Based on monitoring, there were no major mortalities observed in the trees planted as part of this project. The long-term maintenance plan for the site is for the Austin Watershed Protection Department (WPD) to uphold the area's designation as an official grow zone, where mowing is prohibited. This should allow for natural regeneration of both woody and herbaceous vegetation to occur within the Project Area.

The updated Projected CO₂ stored and credit issuance over 25 years is outlined below:

Area Reforestation Plantings	Projection at Initial Crediting	Updated Projection at Year 4	Updated Projection at Year 6
Total credits issued at Initial Crediting (10% CO ₂ (t))	44	44	44
Total credits issued at Year 4 (40% CO ₂ (t))	174	156	156

Total credits to be issued at Year 6 (30% CO2 (t))	131	117	58
Total credits to be issued at Year 26 (20% CO2 (t))	87	73	39
Total credits to be issued (tCO2e)	436	390	297

Attachment: 7-AreaReforestation_CreditTool-PJ002_Yr6.xlsx
8 Area_Reforestation_Quantification_Monitoring_Standards_South_Central
9 Geospatial Data

CO-BENEFITS QUANTIFICATION DOCUMENTATION (Section 9 and Appendix B)

Summarize co-benefit quantification and provide supporting documentation. If necessary, update the CFC-provided Co-Benefits Quantification spreadsheet to calculate updated rainfall interception, reduction of certain air compounds, and energy savings.

Single Tree – Davis-White Park & Patterson Park

<i>Ecosystem Services</i>	<i>Resource Units</i>	<i>Value</i>
Rainfall Interception (m3/yr)	468.28	\$1,224.69
Air Quality (t/yr)	-0.0126	-\$197.30
Cooling – Electricity (kWh/yr)	3,728.97	\$283.03
Heating – Natural Gas (kBtu/yr)	14,455.96	\$150.20
Grand Total (\$/yr)	-	\$1,460.62

The single tree co-benefits estimates have been revised since year 4 to reflect the higher observed mortality percentage (21%), and to take into account the differing observed mortality rates between tree types.

Attachment: 1 PJ002 SingleTree_CreditTool_Yr6.xlsx

Area Reforestation – Onion Creek Riparian Canopy Planting

<i>Ecosystem Services</i>	<i>Resource Units (Adjusted in Year 4, still valid)</i>	<i>Value (Adjusted in Year 4, still valid)</i>
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Rainfall Interception (m3/yr)	387.49	\$1,013.51
Air Quality (t/yr)	0.0865	\$209.08
Cooling – Electricity (kWh/yr)	19,712.35	\$1,496.17
Heating – Natural Gas (kBtu/yr)	10,339.88	\$107.44
Grand Total (\$/yr)	-	\$2,826.19

Attachment: 7-AreaReforestation_CreditTool-PJ002_Yr6.xlsx

ADDITIONAL INFORMATION

Include additional information on changes to monitoring and reporting plans since the Year 4 Planting Design Document was submitted.

No additional information.

SIGNATURE

Signed on February 14 in 2024, by Valerie Tamburri, for TreeFolks, INC.



Signature

Valerie Tamburri
Printed Name

512-443-5323
Phone

valerie@treefolks.org
Email

ATTACHMENTS

- 1-SingleTree_CreditTool-PJ002_Yr6
- 2-SingleTree_GeocodedPhotos-PJ002_Yr6
- 3-SingleTree_PhotoMap-PJ002_Yr6
- 4-iTreeCanopyCalculator-Lens_DataPoints_Yr6
- 5-iTree Canopy Formula References
- 6-iTree_Yr6_SamplingImage-PJ002_Yr6
- 7-AreaReforestation_CreditTool_Yr6
- 8 Area_Reforestation_Quantification_Monitoring_Standards_South_Central
- 9 Geospatial data

Attachments

Canopy

[iTree Canopy Calculator](#)

[Project Area Map and Sampling Imagery](#)

[Carbon Quantification Year 6 Credit Tool - Canopy & Single Tree](#)

[Quantification Approach](#)

[iTree Canopy Formula References](#)

i-Tree Canopy Calculator

Site	Acres	YEAR 4										YEAR 6										YEAR 26									
		Percentage					Area					Percentage					Area					Percentage					Area				
		Old Growth	New Growth	TOTAL	Non-Tree	TOTAL	Old Growth	New Growth	TOTAL	Non-Tree	TOTAL	SE	Old Growth	New Growth	TOTAL	Non-Tree	TOTAL	SE	Old Growth	New Growth	TOTAL	Non-Tree	TOTAL	SE	Old Growth	New Growth	TOTAL	Non-Tree	TOTAL	SE	
1	3.85	23.92%	13.62%	37.54%	62.46%	0.92	0.52	1.45	2.40	4.44%	-	23.92%	31.08%	55.00%	45.00%	0.92	1.20	2.12	1.73	2.87%	-	23.92%	-	-	-	0.92	-	-	-	-	
Total	3.85	23.92%	13.62%	37.54%	62.46%	0.92	0.52	1.45	2.40	4.44%	-	23.92%	31.08%	55.00%	45.00%	0.92	1.20	2.12	1.73	2.87%	-	23.92%	-	-	-	0.92	-	-	-	-	

	Tree %	Non-Tree %
Baseline	23.92%	-
Year 4	37.54%	62.46%
Year 6	55.00%	45.00%
Year 26	-	-

	% Canopy Cover Increase
Baseline - Year 4:	+13.62%
Year 4 - Year 6:	+17.46%
Year 6 - Year 26:	-

NOTE: the values listed as "Old Growth" for each years analyses are taken from the results of the Baseline survey. For the 26 year duration of this project the term "Old Growth" refers to established canopy that existed within the planting area BEFORE the PO (TreeFolks) conducted any planting activities.

Fill out the tables for each site in the below tabs to auto-fill this sheet.
DO NOT enter any values into the cells on this sheet, unless highlighted in yellow

Id	Year 6 Class	Year 26 Class
1	Tree	
2	Tree	
3	Non-Tree	
4	Tree	
5	Tree	
6	Tree	
7	Tree	
8	Tree	
9	Non-Tree	
10	Tree	
11	Non-Tree	
12	Non-Tree	
13	Non-Tree	
14	Tree	
15	Non-Tree	
16	Tree	
17	Tree	
18	Tree	
19	Tree	
20	Tree	
21	Tree	
22	Non-Tree	
23	Tree	
24	Non-Tree	
25	Non-Tree	
26	Tree	
27	Tree	
28	Non-Tree	
29	Tree	
30	Tree	
31	Non-Tree	
32	Tree	

		Year 6	Year 26
	Imagery Date	06/06/23	MM/DD/YY
	Resolution	0.3 meters	XX meters
COUNT	Tree	165	0
	Non-Tree	135	0
%	Tree	55.00%	-
	Non-Tree	45.00%	-
SE	-	2.87%	-

Follow the SOP as described in [this document](#)

Id	Year 6 Coord.	Year 26 Coord.
1	30.1686972	-97.743
2	30.1680315	-97.744
3	30.170001	-97.742
4	30.169246	-97.743
5	30.1706484	-97.742
6	30.1691711	-97.743
7	30.1705125	-97.742
8	30.1696025	-97.743
9	30.1693009	-97.743
10	30.1680834	-97.744
11	30.1686877	-97.744
12	30.1680023	-97.744
13	30.1683994	-97.744
14	30.168406	-97.744
15	30.1702129	-97.742
16	30.1696751	-97.743
17	30.1695298	-97.743
18	30.1677416	-97.745
19	30.1696049	-97.743
20	30.1705648	-97.742
21	30.1706611	-97.742
22	30.1697677	-97.743
23	30.1692992	-97.743
24	30.1704558	-97.742
25	30.1687401	-97.743
26	30.1677264	-97.744
27	30.168994	-97.743
28	30.1704562	-97.742
29	30.1694172	-97.743
30	30.1679973	-97.744
31	30.1703016	-97.742
32	30.1701915	-97.742

33	Non-Tree
34	Non-Tree
35	Non-Tree
36	Non-Tree
37	Non-Tree
38	Tree
39	Non-Tree
40	Tree
41	Non-Tree
42	Tree
43	Non-Tree
44	Tree
45	Tree
46	Non-Tree
47	Tree
48	Tree
49	Non-Tree
50	Non-Tree
51	Non-Tree
52	Tree
53	Non-Tree
54	Tree
55	Non-Tree
56	Tree
57	Tree
58	Tree
59	Tree
60	Non-Tree
61	Non-Tree
62	Tree
63	Tree
64	Tree

33	30.1703223	-97.742
34	30.1683204	-97.744
35	30.1707225	-97.742
36	30.1690962	-97.743
37	30.1702809	-97.742
38	30.1691417	-97.743
39	30.1707059	-97.742
40	30.1701493	-97.742
41	30.1697709	-97.743
42	30.1708882	-97.742
43	30.1691326	-97.743
44	30.1695776	-97.743
45	30.1679614	-97.744
46	30.1678729	-97.744
47	30.1689233	-97.743
48	30.1692858	-97.743
49	30.1708228	-97.742
50	30.1683628	-97.744
51	30.1704064	-97.742
52	30.1688862	-97.743
53	30.1705286	-97.742
54	30.1694774	-97.743
55	30.1702826	-97.742
56	30.168354	-97.744
57	30.1708573	-97.742
58	30.1705798	-97.742
59	30.1689729	-97.743
60	30.1706044	-97.742
61	30.1682906	-97.744
62	30.1706622	-97.742
63	30.1702804	-97.742
64	30.1677753	-97.744

65	Tree
66	Non-Tree
67	Tree
68	Tree
69	Non-Tree
70	Non-Tree
71	Tree
72	Non-Tree
73	Tree
74	Non-Tree
75	Tree
76	Tree
77	Tree
78	Non-Tree
79	Tree
80	Tree
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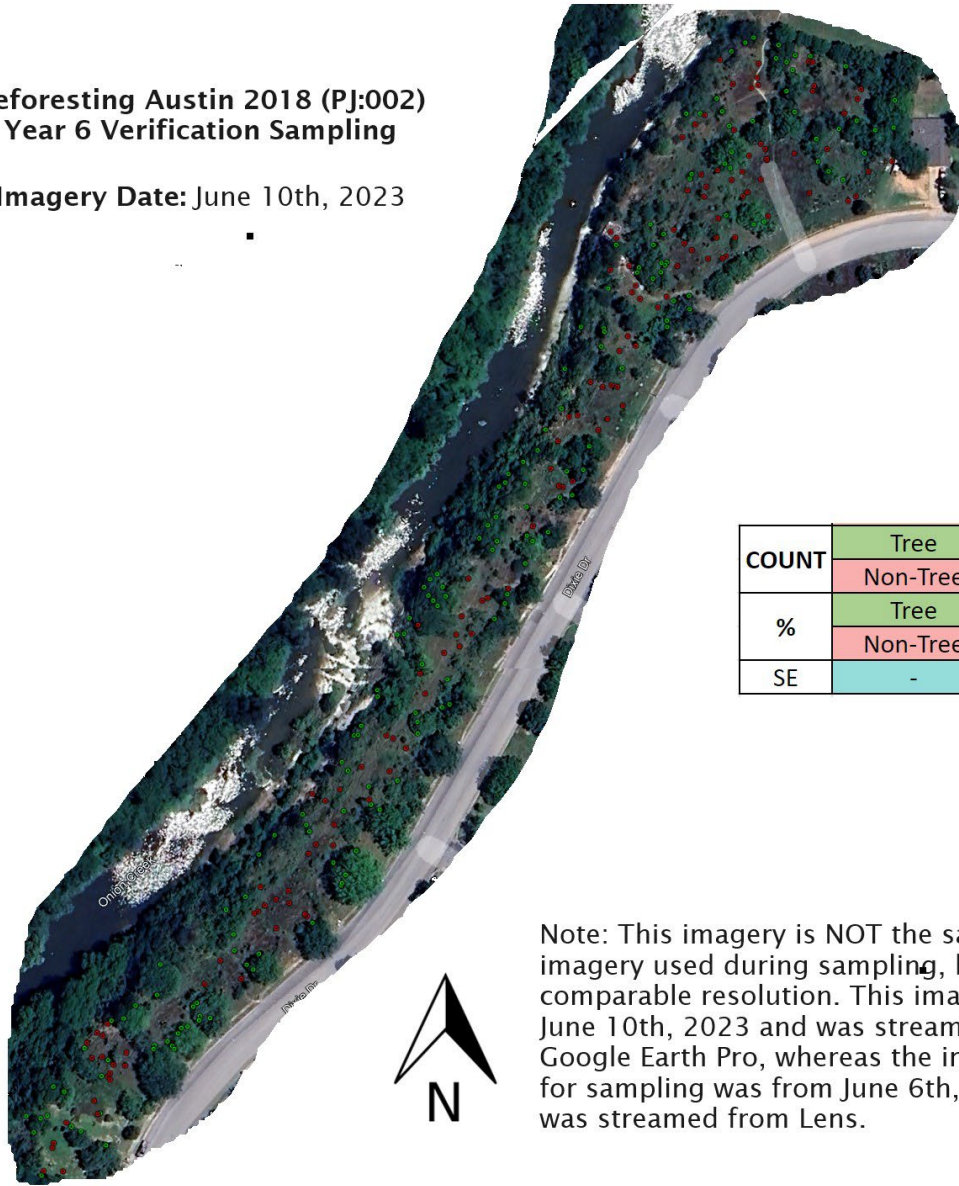
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Project Area Map and Sampling Imagery

**Reforestation Austin 2018 (PJ:002)
Year 6 Verification Sampling**

Imagery Date: June 10th, 2023



COUNT	Tree	165
	Non-Tree	135
%	Tree	55.00%
	Non-Tree	45.00%
SE	-	2.87%

Note: This imagery is NOT the same as the imagery used during sampling, but is of a comparable resolution. This imagery is from June 10th, 2023 and was streamed through Google Earth Pro, whereas the imagery used for sampling was from June 6th, 2023 and was streamed from Lens.

Carbon Quantification Year 6 Credit Tool - Single Tree & Area Reforestation

Directions

- 1) In Table 1 record the number of sites planted for each tree species.
- 2) If species are not listed, add them to the bottom of Table 1.

Table 1. Planting List

Scientific Name	Common Name	Tree-Type Abbreviation	No. Sites Planted
Cercis canadensis var. texensis	Texas Redbud	BDS	7
Platanus mexicana	Mexican Sycamore	BDL	8
Chilopsis linearis	Desert Willow	BDM	5
Carya illinoensis	pecan	BDL	4
Ulmus crassifolia	Cedar Elm	BDL	4
Acacia farnesiana	Huisache	BDS	4
Quercus buckleyi	Texas Red Oak	BDL	3
Quercus polymorpha	Monterrey Oak	BDL	3
Ungnadia speciosa	Mexican Buckeye	BDS	2
Quercus laceyi	Lacey Oak	BDL	2
Diospyros texana	Texas Persimmon	BDM	2
Eysenhardtia texana	Texas Kidneywood	BDS	2
Sapindus saponaria	Western Soapberry	BDM	1
Quercus fusiformis	Plateau Live Oak	BEM	1
Sophora secundiflora	Texas Mountain Laurel	BES	1
Cotinus obovatus	American Smoke Tree	BDS	1
Quercus macrocarpa	bur oak	BDL	0
Louisaena retusa	Goldenball Leadtree	BDS	0
Abies concolor	white fir	CEL	
Abies species	fir	CEL	
Acacia baileyana	Bailey acacia	BES	
Acer buergerianum	trident maple	BDS	
Acer campestre	hedge maple	BDM	
Acer ginnala	Amur maple	BDS	
Acer griseum	paperbark maple	BDS	
Acer macrophyllum	bigleaf maple	BDL	
Acer negundo	boxelder	BDM	
Acer nigrum	black maple	BDL	
Acer palmatum	Japanese maple	BDS	
Acer platanoides	Norway maple	BDL	
Acer rubrum	red maple	BDM	
Acer saccharinum	silver maple	BDL	
Acer saccharum	sugar maple	BDL	
Acer truncatum	purplebark maple	BDS	
Acer x freemanii	Freeman maple	BDL	
Aesculus glabra	Ditch buckeye	BDL	
Aesculus hippocastanum	horsechestnut	BDL	
Aesculus octandra	yellow buckeye	BDL	
Aesculus pavia	red buckeye	BDS	
Ailanthus altissima	tree of heaven	BDM	
Albizia julibrissin	mimosa	BDS	
Amelanchier arborea	downy serviceberry	BDS	
Amelanchier species	serviceberry	BDS	
Karwinska araucana	monkspuzzle tree	CEL	
Asimina triloba	pawpaw	BDS	
Aucuba species	acuba	BES	
Betula lenta	black birch	BDM	
Betula nigra	river birch	BDM	
Betula papyrifera	paper birch	BDL	
Betula pendula	European white birch	BDM	
Betula platyphylla	Asian white birch	BDM	
Betula utilis	Indian paper birch	BDM	
Broadleaf Deciduous Large	broadleaf deciduous large	BDL	
Broadleaf Deciduous Medium	broadleaf deciduous medium	BDM	
Broadleaf Deciduous Small	broadleaf deciduous small	BDS	
Broadleaf Evergreen Large	broadleaf evergreen large	BEL	
Broadleaf Evergreen Medium	broadleaf evergreen medium	BEM	
Broadleaf Evergreen Small	broadleaf evergreen small	BES	
Broussonetia papyrifera	paper mulberry	BDM	
Buddleja davidii	orange eye butterflybush	BDS	
Buxus species	boxwood	BES	
Camellia japonica	camellia	BES	
Carpinus betulus	European hornbeam	BDM	
Carpinus caroliniana	American hornbeam	BDM	
Carya cordiformis	bitternut hickory	BDL	
Carya glabra	pinut hickory	BDL	
Carya ovata	shagbark hickory	BDL	
Carya species	hickory	BDL	
Carya tomentosa	mockernut hickory	BDL	
Castanea dentata	American chestnut	BDL	
Castanea mollissima	Chinese chestnut	BDM	
Catalpa speciosa	northern catalpa	BDL	
Cedrus atlantica	Atlas cedar	CEL	
Cedrus deodara	deodar cedar	CEL	
Celtis laevigata	sugarberry	BDL	
Celtis occidentalis	northern hackberry	BDL	
Celtis species	hackberry	BDL	
Cercidiphyllum japonicum	katsura tree	BDM	
Cercis canadensis	eastern redbud	BDS	
Chamaecyparis lawsoniana	Port Orford cedar	CEL	
Chamaecyparis pisifera	Sawaii false cypress	CES	
Chamaecyparis thuyoides	Atlantic white cedar	CEM	
Chionanthus retusus	Chinese fringe tree	BDS	
Chionanthus virginicus	fringetree	BDS	
Cladostemma kentsukea	yellowwood	BDM	
Clerodendrum trichotomum	harlequin glorybower	BDS	
Conifer Evergreen Large	conifer evergreen large	CEL	
Conifer Evergreen Medium	conifer evergreen medium	CEM	
Conifer Evergreen Small	conifer evergreen small	CES	
Cornus alternifolia	alternateleaf dogwood	BDS	
Cornus florida	flowering dogwood	BDS	
Cornus kousa	Kousa dogwood	BDS	
Cornus mas	cornelian cherry	BDS	
Cornus species	dogwood	BDS	
Cotinus coggygria	smoke tree	BDS	
Crataegus phaenopyrum	Washington hawthorn	BDS	
Crataegus species	hawthorn	BDS	
Crataegus viridis	green hawthorn	BDS	
Cryptomeria japonica	Japanese red cedar	CEL	
Cunninghamia lanceolata	blue Chinese fir	CEL	
Diospyros virginiana	common persimmon	BDM	
Elaeagnus umbellata	autumn olive	BEL	
Eucalyptus species	gum	BEL	
Fagus grandifolia	American beech	BDL	
Fagus sylvatica	European beech	BDL	
Ficus carica	common fig	BDM	
Firmiana simplex	Chinese parasol tree	BDM	
Forsythia species	forsythia	BDS	
Fraxinus americana	white ash	BDL	
Fraxinus nigra	black ash	BDM	
Fraxinus pennsylvanica	green ash	BDL	
Fraxinus quadrangulata	blue ash	BDL	
Ginkgo biloba	ginkgo	BDL	
Gleditsia triacanthos	honeylocust	BDL	
Gymnocladus dioica	Kentucky coffeetree	BDL	
Hakea species	hakea	BES	
Halesia carolina	snowdrop tree	BDM	
Hamamelis virginiana	witch hazel	BDS	
Hibiscus syriacus	rose-of-sharon	BDS	
Ilex aquifolium	English holly	BES	
Ilex cassine	dahoon	BES	
Ilex cornuta	Chinese holly	BES	
Ilex opaca	American holly	BES	
Ilex species	holly	BES	
Juglans nigra	black walnut	BDL	
Juglans regia	English walnut	BDL	
Juniperus species	juniper	CEM	
Juniperus virginiana	eastern red cedar	CEM	
Koeleruteria paniculata	goldenrain tree	BDM	
Lagerstroemia species	common crape myrtle	BDS	
Larix decidua	European larch	BDL	
Ligustrum species	privet	BES	
Liquidambar styraciflua	sweetgum	BDL	
Liriodendron tulipifera	tulip tree	BDL	
Maclura pomifera	Osage orange	BDM	
Magnolia acuminata	cucumber tree	BDL	
Magnolia grandiflora	southern magnolia	BEM	
Magnolia species	magnolia	BDM	
Magnolia stellata	star magnolia	BDS	
Magnolia virginiana	sweetbay	BEM	
Magnolia x soulangiana	Chinese magnolia, saucer magnolia	BDS	
Mahonia bealei	leatherleaf mahonia	BES	
Malus species	apple	BDS	
Malus sylvestris	paradise apple	BDS	
Malus tschonoskii	crabapple	BDS	
Melia azadirach	Chinaberry	BDM	
Metasequoia glyptostroboides	dawn redwood	BDL	
Morus rubra	red mulberry	BDL	
Morus species	mulberry	BDM	
Myrica cerifera	southern bayberry	BES	
Nyssa sylvatica	black tupelo	BDL	
Ostrya virginiana	eastern hophornbeam	BDM	
Palm Evergreen Large	palm evergreen large	PEL	
Palm Evergreen Medium	palm evergreen medium	PEM	
Palm Evergreen Small	palm evergreen small	PES	
Paulownia tomentosa	royal paulownia	BDM	
Phellodendron amurense	Amur corktree	BDM	
Phoenix dactylifera	date palm	PEL	
Photinia species	chokeberry	BES	
Photinia x fraseri	Fraser photinia	BES	
Picea abies	Norway spruce	CEL	
Picea glauca	white spruce	CEL	
Picea pungens	blue spruce	CEL	
Picea species	spruce	CEL	
Pinus contorta var. bolanderi	Bolander beach pine	CES	
Pinus contorta var. latifolia	tall lodgepole pine	CEL	
Pinus echinata	shortleaf pine	CEL	
Pinus mugo	sweet mountain pine	CES	
Pinus nigra	Austrian pine	CEL	
Pinus palustris	longleaf pine	CEL	
Pinus resinosa	red pine	CEL	
Pinus species	pine	CEL	
Pinus strobus	eastern white pine	CEL	
Pinus sylvestris	Scotch pine	CEM	
Pinus taeda	loblolly pine	CEL	
Pinus virginiana	Virginia pine	CEM	
Pistacia chinensis	Chinese pistache	BDM	
Platanus acerifolia	London planetree	BDL	
Platanus occidentalis	American sycamore	BDL	
Populus alba	white poplar	BDL	
Populus balsamifera	balsam poplar	BDL	
Populus deltoides	eastern cottonwood	BDL	
Populus nigra	black poplar	BDL	
Prunus campanulata	Taiwan cherry	BDS	
Prunus caroliniana	Carolina laurelcherry	BEM	
Prunus cerasifera	cherry plum	BDS	
Prunus padus	European bird cherry	BDM	
Prunus persica	peach	BDS	
Prunus serotina	black cherry	BDL	
Prunus serrulata	Kwanzan cherry	BDS	
Prunus species	plum	BDS	
Prunus subhirtella	Higan cherry	BDS	
Prunus tomentosa	Manchu cherry	BDS	

Table 2a. Summary of Planting Sites

Tree Type	Tree-Type Abbreviation	No. Sites Planted
Brdf Decid Large (>50 ft)	BDL	21
Brdf Decid Med (30-50 ft)	BDM	8
Brdf Decid Small (<30 ft)	BDS	10
Brdf Evgrm Large (>50 ft)	BEL	0
Brdf Evgrm Med (30-50 ft)	BEM	1
Brdf Evgrm Small (<30 ft)	BES	1
Conif Evgrm Large (>50 ft)	CEL	0
Conif Evgrm Med (30-50 ft)	CEM	0
Conif Evgrm Small (<30 ft)	CES	0
Total Sites Planted		47

Table 2b. Summary of Planting Sites with Species Names and Replacement Notes

Scientific Name	Common Name	Tree-Type Abbreviation	Original Planted	Updated Count with Replacements	Year 4 Updates from Initial Crediting Planting List	Year 6 Updates from Initial Crediting Planting List
Cercis canadensis var. texensis	Texas Redbud	BDS	7	7		
Platanus mexicana	Mexican Sycamore	BDL	5	5		
Chilopsis linearis	Desert Willow	BDM	5	5		
Carya illinoensis	pecan	BDL	4	4		
Ulmus crassifolia	Cedar Elm	BDL	4	4		
Quercus polymorpha	Monterrey Oak	BDL	4	3	1 Originally 4 were planted, but one died and was replaced by <i>Acacia farnesiana</i>	
Acacia farnesiana	Huisache	BDS	3	4	1 Includes replacement of original tree <i>Quercus polymorpha</i> at site PAT-2	
Quercus buckleyi	Texas Red Oak	BDL	3	3		
Ungnadia speciosa	Mexican Buckeye	BDS	2	2		
Quercus laceyi	Lacey Oak	BDL	2	2		
Diospyros texana	Texas Persimmon	BDM	2	2		
Sophora secundiflora	Texas Mountain Laurel	BES	2	1	1 Originally 2 were planted, but one died and was replaced by <i>Cotinus</i>	
Eysenhardtia texana	Texas Kidneywood	BDS	1	2	1 Includes replacement of original tree <i>Quercus macrocarpa</i> at site PAT-1	
Sapindus saponaria	Western Soapberry	BDM	1	1		
Quercus fusiformis	Plateau Live Oak	BEM	1	1		
Quercus macrocarpa	Bur oak	BDL	1	0	0 Died and was replaced by <i>Eysenhardtia texana</i>	
Cotinus obovatus	American Smoke Tree	BDS	0	1	1 Replaced original tree <i>Sophora secundiflora</i> at site PAT-12	
			47	47		

Prunus yedoensis	Yoshino flowering cherry	BDS	
Pseudotsuga menziesii	Douglas fir	CEL	
Pyracantha koidzumii	Formosa firethorn	BES	
Pyracantha species	firethorn	BES	
Pyrus calleryana	Callery pear	BDS	
Pyrus communis	common pear	BDM	
Pyrus species	pear	BDM	
Quercus acutissima	sawtooth oak	BDM	
Quercus alba	white oak	BDL	
Quercus bicolor	swamp white oak	BDL	
Quercus coccinea	scarlet oak	BDL	
Quercus ellipsoidalis	northern pin oak	BDL	
Quercus falcata	southern red oak	BDL	
Quercus hemisphaerica	Darlington oak	BEL	
Quercus imbricaria	shingle oak	BDL	
Quercus lyrata	oevercup oak	BDM	
Quercus marilandica	blackjack oak	BDM	
Quercus michauxii	swamp chestnut oak	BDL	
Quercus muehlenbergii	chinkapin oak	BDL	
Quercus nigra	water oak	BEL	
Quercus palustris	pin oak	BDL	
Quercus phellos	willow oak	BDL	
Quercus robur	English oak	BDL	
Quercus rubra	northern red oak	BDL	
Quercus shumardii	Shumard oak	BDL	
Quercus stellata	post oak	BDL	
Quercus velutina	black oak	BDL	
Quercus virginiana	live oak	BEL	
Rhamnus species	buckthorn	BDS	
Rhus species	sumac	BDS	
Robinia pseudoacacia	black locust	BDL	
Rosa banksiae	banksian rose, Lady Bank's rose	BDS	
Sabal palmetto	cabbage palmetto	PEM	
Salix gracilistyla	rosegold pussy willow	BDS	
Salix matsudana	corkscrew willow	BDS	
Salix nigra	black willow	BDM	
Salix species	willow	BDL	
Salix x pendulina Wenderoth	Wisconsin weeping willow	BDL	
Sapinum sebiferum	tallowtree	BDM	
Sassafras albidum	sassafras	BDL	
Serenoa repens	saw palmetto	PES	
Shrub	unknown shrub	BDS OTHER	
Sophora japonica	japanese pagoda tree	BDM	
Sorbus aucuparia	European mountain ash	BDM	
Styrax japonicus	japanese snowbell	BDS	
Syringa reticulata	japanese tree lilac	BDS	
Syringa species	lilac	BDS	
Taxodium distichum	bald cypress	BDL	
Thuja occidentalis	northern white cedar	CEL	
Thuja plicata	western red cedar	CEL	
Tilia americana	American basswood	BDL	
Tilia cordata	littleleaf linden	BDM	
Torreya taxifolia	Florida torreya	CEI	
Tsuga canadensis	eastern hemlock	CEL	
Ulmus alata	winged elm	BDL	
Ulmus americana	American elm	BDL	
Ulmus parvifolia	Chinese elm	BDL	
Ulmus pumila	Siberian elm	BDL	
Ulmus rubra	slippery elm	BDL	
Ulmus species	elm	BDL	
Unknown	unknown tree	BDM OTHER	
Viburnum prunifolium	blackhaw	BDS	
Viburnum species	viburnum	BDS	
Vitex agnus-castus	chaste tree	BDS	
Washingtonia filifera	California palm	PES	
Washingtonia robusta	Mexican fan palm	PEM	
X Cupressocyparis leylandii	Leyland cypress	CEL	
Yucca species	yucca	PES	
Yukawa serrata	japanese zelkova	BDL	

Data Collection Table

Data Collection Dates: 05/01/2019, 10/03/2022, 07/06/2023

Crew: Collin McMichael (2019), Emma Pett (2019), Marina Weikel (2022 & 2023), Valerie Tamburri (2023), Rebecca Breneman (2023)

Date Planted	Tree ID #	Species	Tree Type	Site ID #	Lat	Long	Image Yr 1	Image Yr 4	Image Yr 6	Live (Orig/Replace #1/Replace #2)	Standing Dead or Vacant Site (2022)	Standing Dead or Vacant Site (2023)	Date Removed	Date Replaced	Notes
3/31/2018	DW-1	Quercus polymorpha	BDL	DW-A	30°18'16.42"	97°39'23.16"	DW-1_2019.05.01	DW-1_2022.10.03	DW-1_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-2	Quercus polymorpha	BDL	DW-B	30°18'14.69"	97°39'17.83"	DW-2_2019.07.10	DW-2_2022.10.03	DW-2_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-3	Quercus polymorpha	BDL	DW-C	30°18'14.85"	97°39'19.20"	DW-3_2019.07.10	DW-3_2022.10.03	DW-3_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-4	Quercus buckleyi	BDL	DW-D	30°18'13.04"	97°39'23.07"	DW-4_2019.05.01	DEAD - NO PHOTO	DW-4_2023.07.06	Orig	Vacant	Vacant	UNKNOWN	N/A	
3/31/2018	DW-5	Quercus buckleyi	BDL	DW-E	30°18'16.24"	97°39'22.61"	DW-5_2019.05.01	DW-5_2022.10.03	DW-5_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-6	Quercus buckleyi	BDL	DW-F	30°18'16.10"	97°39'24.67"	DW-6_2019.07.10	DW-6_2022.10.03	DW-6_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-8	Chilopsis linearis	BDM	DW-G	30°18'13.08"	97°39'24.23"	DW-8_2019.05.01	DW-8_2022.10.03	DW-8_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-9	Chilopsis linearis	BDM	DW-H	30°18'15.41"	97°39'20.40"	DW-9_2019.07.10	DW-9_2022.10.03	DW-9_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-10	Idenensis var. texensis	BDS	DW-I	30°18'13.08"	97°39'23.46"	DW-10_2019.05.01	DW-10_2022.10.03	DW-10_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-11	Idenensis var. texensis	BDS	DW-J	30°18'15.74"	97°39'21.73"	DW-11_2019.05.01	DW-11_2022.10.03	DW-11_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-12	Idenensis var. texensis	BDS	DW-K	30°18'15.99"	97°39'22.42"	DW-12_2019.05.01	DEAD - NO PHOTO	DW-12_2023.07.06	Orig	Vacant	Vacant	UNKNOWN	N/A	
3/31/2018	DW-13	Ulmus crassifolia	BDL	DW-L	30°18'13.15"	97°39'24.56"	DW-13_2019.05.01	DW-13_2022.10.03	DW-13_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-14	Ulmus crassifolia	BDL	DW-M	30°18'14.65"	97°39'24.51"	DW-14_2019.05.01	DW-14_2022.10.03	DW-14_2023.07.06	Orig	Dead, Standing	Dead, Standing	N/A	N/A	
3/31/2018	DW-15	Ulmus crassifolia	BDL	DW-N	30°18'16.20"	97°39'24.31"	DW-15_2019.05.01	DW-15_2022.10.03	DW-15_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-16	Ulmus crassifolia	BDL	DW-O	30°18'15.54"	97°39'22.72"	DW-16_2019.05.01	DW-16_2022.10.03	DW-16_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-17	Acacia farnesiana	BDS	DW-P	30°18'14.40"	97°39'23.59"	DW-17_2019.05.01	DW-17_2022.10.03	DW-17_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-18	Acacia farnesiana	BDS	DW-Q	30°18'15.29"	97°39'20.33"	DW-18_2019.05.01	DW-18_2022.10.03	DW-18_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-19	Acacia farnesiana	BDS	DW-R	30°18'16.20"	97°39'20.91"	DW-19_2019.07.10	DW-19_2022.10.03	DW-19_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-21	Quercus laceyi	BDL	DW-T	30°18'12.78"	97°39'23.74"	DW-21_2019.05.01	DW-21_2022.10.03	DW-21_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-22	Quercus laceyi	BDL	DW-U	30°18'13.18"	97°39'23.68"	DW-22_2019.07.10	DW-22_2022.10.03	DW-22_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-24	Ungnadia speciosa	BDS	DW-W	30°18'13.11"	97°39'23.76"	DW-24_2019.05.01	DW-24_2022.10.03	DW-24_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-25	Ungnadia speciosa	BDS	DW-X	30°18'14.42"	97°39'24.70"	DW-25_2019.05.01	DEAD - NO PHOTO	DW-25_2023.07.06	Orig	Vacant	Vacant	UNKNOWN	N/A	
3/31/2018	DW-26	Platanus mexicana	BDL	DW-Y	30°18'13.04"	97°39'23.16"	DW-26_2019.05.01	DW-26_2022.10.03	DW-26_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-27	Platanus mexicana	BDL	DW-Z	30°18'13.30"	97°39'24.75"	DW-27_2019.05.01	DEAD - NO PHOTO	DW-27_2023.07.06	Orig	Vacant	Vacant	UNKNOWN	N/A	
3/31/2018	DW-28	Platanus mexicana	BDL	DW-AA	30°18'14.77"	97°39'24.59"	DW-28_2019.05.01	DW-28_2022.10.03	DW-28_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-29	Platanus mexicana	BDL	DW-AB	30°18'16.52"	97°39'24.56"	DW-29_2019.05.01	DW-29_2022.10.03	DW-29_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-30	Platanus mexicana	BDL	DW-AC	30°18'15.47"	97°39'20.39"	DW-30_2019.05.01	DW-30_2022.10.03	DW-30_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-33	Carya illinoensis	BDL	DW-AE	30°18'14.47"	97°39'23.88"	DW-33_2019.05.01	DW-33_2022.10.03	DW-33_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-34	Carya illinoensis	BDL	DW-AF	30°18'15.08"	97°39'24.57"	DW-34_2019.05.01	DW-34_2022.10.03	DW-34_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-34	Carya illinoensis	BDL	DW-AG	30°18'15.57"	97°39'20.85"	DW-34_2019.05.01	DW-34_2022.10.03	DW-34_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-35	Carya illinoensis	BDL	DW-AH	30°18'15.80"	97°39'22.72"	DW-35_2019.05.01	DW-35_2022.10.03	DW-35_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/31/2018	DW-36	Spondias saponaria	BDM	DW-AI	30°18'13.57"	97°39'24.81"	DW-36_2019.05.01	DW-36_2022.10.03	DW-36_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-1	Quercus macrocarpa	BDS	PAT-A	30°17'48.26"	97°42'39.07"	PAT-1_2019.05.02	PAT-1_2022.10.03	PAT-1_2023.07.06	Replace #1 (Eysenhardtia texana)	Alive	Alive	N/A	UNKNOWN	*Tree type based on replacement Eysenhardtia texana
3/10/2018	PAT-2	Quercus polymorpha	BDS	PAT-B	30°17'48.57"	97°42'38.41"	PAT-2_2019.05.02	PAT-2_2022.10.03	PAT-2_2023.07.06	Replace #1 (Acacia farnesiana)	Dead, Standing	Dead, Standing	N/A	UNKNOWN	*Tree type based on replacement Acacia farnesiana
3/10/2018	PAT-3	Quercus fusiformis	BEM	PAT-C	30°17'48.74"	97°42'38.83"	PAT-3_2019.05.02	PAT-3_2022.10.03	PAT-3_2023.07.06	Orig	Dead, Standing	Vacant	N/A	N/A	
3/10/2018	PAT-4	Chilopsis linearis	BDM	PAT-D	30°17'48.65"	97°42'39.18"	PAT-4_2019.05.02	PAT-4_2022.10.03	PAT-4_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-5	Chilopsis linearis	BDM	PAT-E	30°17'48.69"	97°42'39.18"	PAT-5_2019.05.02	PAT-5_2022.10.03	PAT-5_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-6	Chilopsis linearis	BDM	PAT-F	30°17'48.76"	97°42'38.77"	PAT-6_2019.05.02	PAT-6_2022.10.03	PAT-6_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-7	Idenensis var. texensis	BDS	PAT-G	30°17'48.46"	97°42'38.72"	PAT-7_2019.05.02	PAT-7_2022.10.03	PAT-7_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-8	Idenensis var. texensis	BDS	PAT-H	30°17'48.66"	97°42'38.55"	PAT-8_2019.05.02	PAT-8_2022.10.03	PAT-8_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-9	Idenensis var. texensis	BDS	PAT-I	30°17'48.73"	97°42'38.66"	PAT-9_2019.05.02	PAT-9_2022.10.03	PAT-9_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-10	Idenensis var. texensis	BDS	PAT-J	30°17'48.50"	97°42'38.61"	PAT-10_2019.05.02	PAT-10_2022.10.03	PAT-10_2023.07.06	Orig	Alive	Vacant	N/A	N/A	
3/10/2018	PAT-11	Lophora secundiflora	BES	PAT-K	30°17'48.64"	97°42'39.24"	PAT-11_2019.05.02	PAT-11_2022.10.03	PAT-11_2023.07.06	Orig	Dead, Standing	Dead, Standing	N/A	N/A	
3/10/2018	PAT-12	Lophora secundiflora	BDS	PAT-L	30°17'48.40"	97°42'38.69"	PAT-12_2019.05.02	DEAD - NO PHOTO	PAT-12_2023.07.06	Replace #1 (Cotinus obovatus)	Vacant	Vacant	UNKNOWN	UNKNOWN	*Tree type based on replacement Cotinus obovatus
3/10/2018	PAT-13	Diospyros texana	BDM	PAT-M	30°17'48.48"	97°42'38.41"	PAT-13_2019.05.02	PAT-13_2022.10.03	PAT-13_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-14	Diospyros texana	BDM	PAT-N	30°17'48.59"	97°42'39.74"	PAT-14_2019.05.02	PAT-14_2022.10.03	PAT-14_2023.07.06	Orig	Alive	Alive	N/A	N/A	
3/10/2018	PAT-15	Eysenhardtia texana	BDS	PAT-O	30°17'48.52"	97°42'39.13"	PAT-15_2019.05.02	PAT-15_2022.10.03	PAT-15_2023.07.06	Orig	Alive	Alive	N/A	N/A	

Tree Type	Standing Dead or Vacant Site (2023)	Count of Tree Type
BDL	Alive	18
	Dead, Standing	1
	Vacant	2
BDM	Alive	8
BDS	Alive	11
	Dead, Standing	1
	Vacant	4
BEM	Vacant	1
BES	Dead, Standing	1
Grand Total		47

In Table 4 the tool infers the amount of CO₂ stored after 25 years based on the population of live trees. Values in column H account for anticipated tree losses and the 5% buffer pool deduction.

Table 4. Grand Total CO₂ Stored after 25 years (all live trees, includes tree losses and buffer pool deduction)

Tree-Type	No. Sites Planted	Mortality Deduction (%)	Total Live Trees After Mortality	25-yr CO ₂ stored (kg/tree)	CO ₂ Total - No Deductions (t)	Grand Total CO ₂ with Deductions (t)
Brdlf Decid Large (>50 ft)	21	0.14	18	3,625.26	76.1	62.0
Brdlf Decid Med (30-50 ft)	8	0.00	8	2,817.57	22.5	21.4
Brdlf Decid Small (<30 ft)	16	0.31	11	2,118.55	33.9	22.1
Brdlf Evgrn Large (>50 ft)	0	0.00	0	0.00	0.0	0.0
Brdlf Evgrn Med (30-50 ft)	1	1.00	0	1,317.96	1.3	0.0
Brdlf Evgrn Small (<30 ft)	1	1.00	0	554.47	0.6	0.0
Conif Evgrn Large (>50 ft)	0	0.00	0	0.00	0.0	0.0
Conif Evgrn Med (30-50 ft)	0	0.00	0	0.00	0.0	0.0
Conif Evgrn Small (<30 ft)	0	0.00	0	0.00	0.0	0.0
	47		37	10,433.8	134.4	105.54

Using the information you provide and background data, the tool provides estimates of co-benefits after 25 years.

Table 5. Co-Benefits per year after 25 years (all live trees, includes tree losses)

Ecosystem Services	Resource Unit Totals	Total \$
Rain Interception (m3/yr)	468.28	\$1,224.69
Air Quality (t/yr)		
O3	0.0029	\$42.43
NOx	0.0012	\$17.84
PM10	0.0031	\$16.77
Net VOCs	-0.0199	-\$274.35
Air Quality Total	-0.0126	-\$197.30
Energy (kWh/yr & kBtu/yr)		
Cooling - Elec.	3,728.97	\$283.03
Heating - Nat. Gas	14,455.96	\$150.20
Energy Total (\$/yr)		\$433.23
Grand Total (\$/yr)		\$1,460.62

Directions

- 1) In Table 1 record the number of sites planted for each tree species.
- 2) If species are not listed, add them to the bottom of Table 1.

Table 1. Planting List

ScientificName	CommonName	Tree-Type Abbreviation	No. Sites Planted
Sophr a secundiflora	Texas Mountainlaurel	BES	120
Gleditsia triacanthos	honeylocust	BDL	100
Frangula caroliniana	Carolina buckthorn	BDS	100
Acacia berlanderi	Guajillo	BDS	100
Acacia farnesiana	Huisache	BDS	100
Parkinsonia aculeata	Retama	BDM	100
Eysenhardtia texana	Kidneywood	BDS	85
Cornus dromundii	Roughleaf Dogwood	BDS	70
Ehretia anacua	Anacua	BDM	60
Sapindus saponaria var. drummondii	Western soapberry	BDM	60
Taxodium distichum	bald cypress	BDL	50
Condalia hookeri	Brazilwood	BDS	50
Ulmus crassifolia	Cedar elm	BDL	50
Prosopis glandulosa	Honey mesquite	BDS	50
Diospyros texana	Texas Persimmon	BDS	50
Aloysia gratissima	Whitebrush	BDS	50
Ulmus americana	American elm	BDL	20
Platanus occidentalis	American sycamore	BDL	10
Callicarpa americana	American Beautyberry	BDS	10
Acacia gregii	Catclaw acacia	BDS	10
Quercus fusiformis	Plateau live oak	BEM	5
Abies concolor	white fir	CEL	0
Abies species	fir	CEL	0
Acacia baileyana	Bailey acacia	BES	0
Acer buergerianum	trident maple	BDS	0
Acer campestre	hedge maple	BDM	0
Acer ginnala	Amur maple	BDS	0
Acer griseum	paperbark maple	BDS	0
Acer macrophyllum	bigleaf maple	BDL	0
Acer negundo	boxelder	BDL	0
Acer nigrum	black maple	BDL	0
Acer palmatum	Japanese maple	BDS	0
Acer platanoides	Norway maple	BDL	0
Acer rubrum	red maple	BDM	0
Acer saccharinum	silver maple	BDL	0
Acer saccharum	sugar maple	BDL	0
Acer truncatum	purplebark maple	BDS	0
Acer x freemanii	Freeman maple	BDL	0
Aesculus glabra	Ohio buckeye	BDL	0
Aesculus hippocastanum	horsechestnut	BDL	0
Aesculus octandra	yellow buckeye	BDL	0
Aesculus pavia	red buckeye	BDS	0
Ailanthus altissima	tree of heaven	BDM	0
Albizia julibrissin	mimosa	BDS	0
Amelanchier arborea	downy serviceberry	BDS	0
Amelanchier species	serviceberry	BDS	0
Araucaria araucana	monkeypuzzle tree	CEL	0
Asimina triloba	pawpaw	BDS	0
Aucuba species	acuba	BES	0
Betula lenta	black birch	BDM	0
Betula nigra	river birch	BDM	0
Betula papyrifera	paper birch	BDL	0
Betula pendula	European white birch	BDM	0
Betula platyphylla	Asian white birch	BDM	0
Betula utilis	Indian paper birch	BDM	0
Broadleaf Deciduous Large	broadleaf deciduous large	BDL	0
Broadleaf Deciduous Medium	broadleaf deciduous medium	BDM	0
Broadleaf Deciduous Small	broadleaf deciduous small	BDS	0
Broadleaf Evergreen Large	broadleaf evergreen large	BEL	0
Broadleaf Evergreen Medium	broadleaf evergreen medium	BEM	0
Broadleaf Evergreen Small	broadleaf evergreen small	BES	0
Broussonetia papyrifera	paper mulberry	BDM	0
Buddleja davidii	orange eye butterflybush	BDS	0
Buxus species	boxwood	BES	0
Camellia japonica	camellia	BES	0
Carpinus betulus	European hornbeam	BDM	0
Carpinus caroliniana	American hornbeam	BDM	0
Carya cordiformis	bitternut hickory	BDL	0
Carya glabra	pignut hickory	BDL	0
Carya illinoensis	pecan	BDL	0
Carya ovata	shagbark hickory	BDL	0
Carya species	hickory	BDL	0
Carya tomentosa	mockernut hickory	BDL	0
Castanea dentata	American chestnut	BDL	0
Castanea mollissima	Chinese chestnut	BDM	0
Catalpa speciosa	northern catalpa	BDL	0
Cedrus atlantica	Atlas cedar	CEL	0
Cedrus deodara	deodar cedar	CEL	0
Celtis laevigata	sugarberry	BDM	0
Celtis occidentalis	northern hackberry	BDL	0
Celtis species	hackberry	BDL	0
Cercidiphyllum japonicum	katsura tree	BDM	0
Cercis canadensis	eastern redbud	BDS	0
Chamaecyparis lawsoniana	Port Orford cedar	CEL	0
Chamaecyparis pisifera	Sawara false cypress	CES	0
Chamaecyparis thyoides	Atlantic white cedar	CEM	0
Chionanthus retusus	Chinese fringe tree	BDS	0
Chionanthus virginicus	fringetree	BDS	0
Cladrastis kentukea	yellowwood	BDM	0
Clerodendrum trichotomum	harlequin glorybower	BDS	0
Conifer Evergreen Large	conifer evergreen large	CEL OTHER	0
Conifer Evergreen Medium	conifer evergreen medium	CEM OTHER	0
Conifer Evergreen Small	conifer evergreen small	CES OTHER	0
Cornus alternifolia	alternateleaf dogwood	BDS	0
Cornus florida	flowering dogwood	BDS	0

Table 2. Summary of Planting Sites

Tree-Type	Tree-Type Abbreviation	No. Sites Planted
Brdlf Decid Large (>50 ft)	BDL	230
Brdlf Decid Med (30-50 ft)	BDM	220
Brdlf Decid Small (<30 ft)	BDS	675
Brdlf Evgrn Large (>50 ft)	BEL	0
Brdlf Evgrn Med (30-50 ft)	BEM	5
Brdlf Evgrn Small (<30 ft)	BES	120
Conif Evgrn Large (>50 ft)	CEL	0
Conif Evgrn Med (30-50 ft)	CEM	0
Conif Evgrn Small (<30 ft)	CES	0
Total Sites Planted		1250

Cornus kousa	Kousa dogwood	BDS	0
Cornus mas	cornelian cherry	BDS	0
Cornus species	dogwood	BDS	0
Cotinus coggygria	smoke tree	BDS	0
Crataegus phaenopyrum	Washington hawthorn	BDS	0
Crataegus species	hawthorn	BDS	0
Crataegus viridis	green hawthorn	BDS	0
Cryptomeria japonica	Japanese red cedar	CEL	0
Cunninghamia lanceolata	blue Chinese fir	CEL	0
Diospyros virginiana	common persimmon	BDM	0
Elaeagnus umbellata	autumn olive	BES	0
Eucalyptus species	gum	BEL	0
Fagus grandifolia	American beech	BDL	0
Fagus sylvatica	European beech	BDL	0
Ficus carica	common fig	BDS	0
Firmiana simplex	Chinese parasol tree	BDM	0
Forsythia species	forsythia	BDS	0
Fraxinus americana	white ash	BDL	0
Fraxinus nigra	black ash	BDM	0
Fraxinus pennsylvanica	green ash	BDL	0
Fraxinus quadrangulata	blue ash	BDL	0
Ginkgo biloba	ginkgo	BDL	0
Gymnocladus dioicus	Kentucky coffeetree	BDL	0
Hakea species	hakea	BES	0
Halesia carolina	snowdrop tree	BDM	0
Hamamelis virginiana	witch hazel	BDS	0
Hibiscus syriacus	rose-of-sharon	BDS	0
Ilex aquifolium	English holly	BES	0
Ilex cassine	dahoon	BES	0
Ilex cornuta	Chinese holly	BES	0
Ilex opaca	American holly	BES	0
Ilex species	holly	BES	0
Juglans nigra	black walnut	BDL	0
Juglans regia	English walnut	BDL	0
Juniperus species	juniper	CEM	0
Juniperus virginiana	eastern red cedar	CEM	0
Koelreuteria paniculata	goldenrain tree	BDM	0
Lagerstroemia species	common crapemyrtle	BDS	0
Larix decidua	European larch	BDL	0
Ligustrum species	privet	BES	0
Liquidambar styraciflua	sweetgum	BDL	0
Liriodendron tulipifera	tulip tree	BDL	0
Maclura pomifera	Osage orange	BDM	0
Magnolia acuminata	cucumber tree	BDL	0
Magnolia grandiflora	southern magnolia	BEM	0
Magnolia species	magnolia	BDM	0
Magnolia stellata	star magnolia	BDS	0
Magnolia virginiana	sweetbay	BEM	0
Magnolia x soulangiana	Chinese magnolia; saucer magnolia	BDS	0
Mahonia bealei	leatherleaf mahonia	BES	0
Malus species	apple	BDS	0
Malus sylvestris	paradise apple	BDS	0
Malus tschonoskii	crabapple	BDS	0
Melia azedarach	Chinaberry	BDM	0
Metasequoia glyptostroboides	dawn redwood	BDL	0
Morus rubra	red mulberry	BDL	0
Morus species	mulberry	BDM	0
Myrica cerifera	southern bayberry	BES	0
Nyssa sylvatica	black tupelo	BDL	0
Ostrya virginiana	eastern hophornbeam	BDM	0
Palm Evergreen Large	palm evergreen large	PEL OTHER	0
Palm Evergreen Medium	palm evergreen medium	PEM OTHER	0
Palm Evergreen Small	palm evergreen small	PES OTHER	0
Paulownia tomentosa	royal paulownia	BDM	0
Phellodendron amurense	Amur corktree	BDM	0
Phoenix dactylifera	date palm	PEL	0
Photinia species	chokeberry	BES	0
Photinia x fraseri	Fraser photinia	BES	0
Picea abies	Norway spruce	CEL	0
Picea glauca	white spruce	CEL	0
Picea pungens	blue spruce	CEL	0
Picea species	spruce	CEL	0
Pinus contorta var. bolanderi	Bolander beach pine	CES	0
Pinus contorta var. latifolia	tall lodgepole pine	CEL	0
Pinus echinata	shortleaf pine	CEL	0
Pinus mugo	sweet mountain pine	CES	0
Pinus nigra	Austrian pine	CEL	0
Pinus palustris	longleaf pine	CEL	0
Pinus resinosa	red pine	CEL	0
Pinus species	pine	CEL	0
Pinus strobus	eastern white pine	CEL	0
Pinus sylvestris	Scotch pine	CEM	0
Pinus taeda	loblolly pine	CEL	0
Pinus virginiana	Virginia pine	CEM	0
Pistacia chinensis	Chinese pistache	BDM	0
Platanus acerifolia	London planetree	BDL	0
Populus alba	white poplar	BDL	0
Populus balsamifera	balsam poplar	BDL	0
Populus deltoides	eastern cottonwood	BDL	0
Populus nigra	black poplar	BDL	0
Prunus campanulata	Taiwan cherry	BDS	0
Prunus caroliniana	Carolina laurelcherry	BEM	0
Prunus cerasifera	cherry plum	BDS	0
Prunus padus	European bird cherry	BDM	0
Prunus persica	peach	BDS	0
Prunus serotina	black cherry	BDL	0
Prunus serrulata	Kwanzan cherry	BDS	0
Prunus species	plum	BDS	0
Prunus subhirtella	Higan cherry	BDS	0
Prunus tomentosa	Manchu cherry	BDS	0
Prunus yedoensis	Yoshino flowering cherry	BDS	0
Pseudotsuga menziesii	Douglas fir	CEL	0
Pyracantha koidzumii	Formosa firethorn	BES	0

Pyracantha species	firethorn	BES	0
Pyrus calleryana	Callery pear	BDS	0
Pyrus communis	common pear	BDM	0
Pyrus species	pear	BDM	0
Quercus acutissima	sawtooth oak	BDM	0
Quercus alba	white oak	BDL	0
Quercus bicolor	swamp white oak	BDL	0
Quercus coccinea	scarlet oak	BDL	0
Quercus ellipsoidalis	northern pin oak	BDL	0
Quercus falcata	southern red oak	BDL	0
Quercus hemisphaerica	Darlington oak	BEL	0
Quercus imbricaria	shingle oak	BDL	0
Quercus lyrata	overcup oak	BDM	0
Quercus macrocarpa	bur oak	BDL	0
Quercus marilandica	blackjack oak	BDM	0
Quercus michauxii	swamp chestnut oak	BDL	0
Quercus muehlenbergii	chinkapin oak	BDL	0
Quercus nigra	water oak	BEL	0
Quercus palustris	pin oak	BDL	0
Quercus phellos	willow oak	BDL	0
Quercus robur	English oak	BDL	0
Quercus rubra	northern red oak	BDL	0
Quercus shumardii	Shumard oak	BDL	0
Quercus stellata	post oak	BDL	0
Quercus velutina	black oak	BDL	0
Quercus virginiana	live oak	BEL	0
Rhamnus species	buckthorn	BDS	0
Rhus species	sumac	BDS	0
Robinia pseudoacacia	black locust	BDL	0
Rosa banksiae	banksian rose; Lady Bank's rose	BDS	0
Sabal palmetto	cabbage palmetto	PEM	0
Salix gracilistyla	rosegold pussy willow	BDS	0
Salix matsudana	corkscrew willow	BDS	0
Salix nigra	black willow	BDM	0
Salix species	willow	BDL	0
Salix x pendulina Wenderoth	Wisconsin weeping willow	BDL	0
Sapium sebiferum	tallowtree	BDM	0
Sassafras albidum	sassafras	BDL	0
Serenoa repens	saw palmetto	PES	0
Shrub	unknown shrub	BDS OTHER	0
Sophora japonica	Japanese pagoda tree	BDM	0
Sorbus aucuparia	European mountain ash	BDM	0
Styrax japonicus	Japanese snowbell	BDS	0
Syringa reticulata	Japanese tree lilac	BDS	0
Syringa species	lilac	BDS	0
Thuja occidentalis	northern white cedar	CEL	0
Thuja plicata	western red cedar	CEL	0
Tilia americana	American basswood	BDL	0
Tilia cordata	littleleaf linden	BDM	0
Torreya taxifolia	Florida torreya	CES	0
Tsuga canadensis	eastern hemlock	CEL	0
Ulmus alata	winged elm	BDL	0
Ulmus parvifolia	Chinese elm	BDL	0
Ulmus pumila	Siberian elm	BDL	0
Ulmus rubra	slippery elm	BDL	0
Ulmus species	elm	BDL	0
Unknown	unknown tree	BDM OTHER	0
Viburnum prunifolium	blackhaw	BDS	0
Viburnum species	viburnum	BDS	0
Vitex agnus-castus	chaste tree	BDS	0
Washingtonia filifera	California palm	PES	0
Washingtonia robusta	Mexican fan palm	PEM	0
x Cupressocyparis leylandii	Leyland cypress	CEL	0
Yucca species	yucca	PES	0
Zelkova serrata	Japanese zelkova	BDL	0

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Directions

- 1) Use i-Tree Canopy, or another tool, to estimate the amount of baseline deciduous and coniferous tree cover area (acres) (Cell C20 and D20).
- 2) Use i-Tree Canopy, or another tool, to estimate the amount of baseline non-tree cover area (acres) (Cell F20) in the project area.
- 3) In Cell G20 the total area of the project is calculated (acres). Prompt i-Tree Canopy to provide an estimate of the project area by clicking on the gear icon next to the upper right portion of the image and selecting "Report By Area."
- 4) Total Project Area, cell G17 should equal 100%.

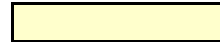
Table 1. Baseline Tree Cover

	Deciduous Tree Cover	Coniferous Tree Cover	Total Tree Cover	Non-Tree Cover	Total Project Area
Percent (%)	23.92%	0%	23.92%	76.08%	100%
Area (sq miles)	0.001	0.000	0.001	0.005	0.01
Area (m2)	3,727	0	3,727	11,853	15,580
Area (acres)	0.92	0.00	0.92	2.93	3.85

Table 2. GHG Emissions

	Acres	CO2 index (tCO2e/acre)	Baseline canopy cover %	GHG Emissions (tCO2e)	5% Buffer Pool Deduction	Grand Total CO2 w/ Deductions (t)	10%	40%	30%	20%	
							Year 0 10% CO ₂ (t)	Year 4 30% CO ₂ (t)	Year 6 30% CO ₂ (t)	Year 26 20% CO ₂ (t)	sumcheck
Total GHG Reduc	3.85	106.7	23.92%	313	16	297.00	29.70	118.80	89.10	59.40	297
Carbon Credits						297	44	156	58	39	297
						15.63	1.56	6.25	4.69	3.13	16
Buffer Credits						16	2	8	4	2	16

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Directions

1) Use i-Tree Canopy, or another tool, to estimate the amount of tree cover area (acres) (Cell C18) that the planted tree sites will provide at 25-years after planting.

2) Use i-Tree Canopy, or another tool, to estimate the amount of non-tree cover area (acres) (Cell D18) in the project area.

3) In Cell E18 the total area of the project is calculated (acres). By clicking on the gear icon next to the upper right portion of the image and selecting "Report By Area" you can prompt i-Tree Canopy to provide an estimate of the area.

4) Total Project Area, cell E15 should equal 100%.

Table 6. Tree Cover

	Tree Cover	Non-Tree Cover	Total Project
Percent (%)	100%	0%	100%
Area (sq miles)	0.006	0.000	0.01
Area (m2)	15,580	0	15,580
Area (acres)	3.85	0.00	3.85

Using the information on species and acreage of project area, the tool provides estimates of co-benefits after 25 years and at full canopy in Resource Units and \$ per year. These are first-order approximations based on values from i-Tree Streets.

Table 8. Co-Benefits per year after 25 years

Ecosystem Services	Resource Units Totals	Total \$
Rain Interception (m3/yr)	387.49	\$1,013.51
Air Quality (t/yr)		
O3	0.0481	\$142.87
NOx	0.0119	\$35.47
PM10	0.0260	\$29.32
Net VOCs	0.0005	\$1.41
Air Quality Total	0.0865	\$209.08
Energy (kWh/yr & kBtu/yr)		
Cooling - Elec.	19,712.35	\$1,496.17
Heating - Nat. Gas	10,339.88	\$107.44
Energy Total (\$/yr)		\$1,603.60
Grand Total (\$/yr)		\$2,826.19

Quantification Approach



City Forest Credits Planting Protocol

Area Reforestation Quantification and Monitoring

Standards and Requirements in the South Central Climate Zone

Carbon Quantification

Area Reforestation planting projects can request Carbon Removal Forward Credits™ from City Forest Credits (CFC):

- 10% after planting is completed
- 30% at Year 4
- 30% at Year 6
- 10% at Year 14
- Remaining credits at end of project duration (at Year 26)

The Credits will be based on the quantification performed by our forest scientists. Their calculations are in turn based on information Project Operators provide, including:

- Species planted
- Numbers of each species
- Planting design – density, expected mortality etc.
- Number of acres planted
- If the project is planted in separate areas, then Project Operator provides the planting list for each area

Scientists at City Forest Credits originally developed two separate methods for quantifying carbon dioxide (CO₂) storage in urban forest carbon projects – the Single Tree Approach (where planted trees are few or are scattered among many existing trees) and the Tree Canopy Approach (where planted trees are relatively contiguous). Instead of using the traditional Tree Canopy Approach for riparian tree planting projects in Austin, we use a forest ecosystem approach. The traditional Tree Canopy Approach, which is based on the biometrics of open-growing urban trees, does not always adequately describe biomass distribution among closely spaced trees and the dynamic changes in CO₂ stored in dead wood and understory vegetation as a riparian forest stand matures. This quantification method is now referred to as Area Reforestation Quantification Method.

In our modified approach the amount of CO₂ stored after 25-years by planted project trees is based on the anticipated amount of tree canopy area (TC). The forecasted amount of CO₂ stored after 25 years is the product of the amount of tree canopy (TC) and the CO₂ Index (CI, t CO₂ per acre). This amount is the value from which the Registry issues credits in the amounts of 10%, 30%, 30%, and 10% at Years 1, 4, 6 and 14 after planting, respectively. A 5% buffer pool deduction is applied, with these funds going into a

program-wide pool to insure against catastrophic loss of trees. At the end of the project, in year 26, the Project Operator will receive credits for all CO₂ stored, minus credits already issued.

To provide an accurate and complete accounting of carbon pools in these projects using the Area Reforestation Quantification Method we used the US Forest Service General Technical Report (GTR) NE-343, with its allometrics for the elm/ash/cottonwood forest ecosystem in the South Central region¹. The table we used (B46) provides carbon stored per hectare for each of six pools as a function of stand age. We used values for 25-year old stands for afforestation projects, because the sites contain little carbon in down dead wood and forest floor material at the time of planting. Data used to derive the 51 forest ecosystem tables came from U.S. Forest Inventory and Assessment plots. More information on methods used to prepare the tables can be found in Smith et al. (2006).

Following guidance in GTR NE-343 we adjusted the GTR NE-343 values for live wood, dead standing and dead down wood using local plot data provided by the team. According to the plot data the mean amount of C stored in all tree biomass was 24 t/ha. This value does not include biomass of invasive woody species. Lacking a measured breakdown of this total for trees among the live, standing dead, and down dead biomass components, the 24 t/ha was proportionately distributed as per the GTR (i.e., live: 87%, 20.9 t/ha; standing dead: 7%, 1.7 t/ha; down dead: 6%, 1.4 t/ha). The remaining three carbon pools (understory, forest floor, and soil) remained the same as in GTR Table B46 because their values are independent of tree biomass. The customized values are shown below in Table 1. Carbon in the tree pool totals 24 t/ha and accounts for 33% of the total 71.9 t/ha after 25 years for this forest ecosystem. Soil organic carbon is the single largest pool (56%).

After conversions, **the CO₂ Index (CI) is 106.7 t CO₂ per acre of tree canopy (TC) and the forecasted amount of CO₂ stored after 25-years is the CI x TC.** This is the value from which the Registry will issue forward credits (Table 1).

Table 1. Estimated amounts of carbon stored in each pool 25-years after planting for Area Reforestation projects near Austin, TX. These values are based on local plot data for the types of forests and values from GTR NE-343 for the elm/ash/cottonwood forest ecosystem in the South Central region.

elm/ash/cottonwood	t/C/ha	t/CO ₂ /ha	t/CO ₂ /ac	% total
live tree	20.9	76.8	31.08	29%
std dead tree	1.7	6.1	2.48	2%
understory	3.3	12.1	4.90	5%
down dead wood	1.4	5.1	2.07	2%
forest floor	4.4	16.1	6.53	6%
soil	40.2	147.4	59.68	56%
total	71.9	263.6	106.73	100%

¹ Smith, James E.; Heath, Linda S.; Skog, Kenneth E.; Birdsey, Richard A. 2006. Methods for calculating forest ecosystem and harvested carbon with standard estimates for forest types of the United States. Gen. Tech. Rep. NE-343. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 216 p.

Monitoring Requirements

Project Operators need to submit annual monitoring reports. At years when Credits are requested, Project Operators need to provide additional information.

Within one year of planting:

- Request for Third-Party Verification and Credits
 - Project Design Document, which includes quantification
- Maps of the site, with boundaries, as well as a map showing the site within a larger context of land area, such as within a neighborhood, city or region
- Document the planting through imaging of the trees or photos
 - Select points and take geo-coded photos that when taken together capture the newly planted trees in the project area
 - If site is rectilinear, take a photo at each of the corners. If the site is large, take photos at points along the perimeter looking into the project area. If necessary to capture the trees, take photos facing each of the cardinal directions while standing in the middle of the project area
 - If site is nonrectilinear, identify critical points along property boundaries and take photographs at each point facing in towards the middle of the site. Next, take photographs from the middle of the project area facing out at each cardinal direction.
- Attestation of Planting
 - Include supporting documentation listed on the Project Operator Declaration of Planting template
- Attestation of Planting Affirmation
- Attestation of Land Ownership or Agreement to Transfer Credits
- Attestation of No Double Counting and No Net Harm
- Attestation of Additionality

At Year 4, 6, and 14:

- Project Operator either conducts a physical tree count using plots or uses imaging of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres).
 - Imaging from Google Earth with leaf-on may be used. Project Operators will calculate the percent of canopy cover from the Google Earth imaging
 - Project Operators can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.
 - If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as

with randomly placed points, and the percentage tree cover classification accuracy reported.

- Progress Requirements at Year 4, 6, and 14:
 - At Year 4, projects must show canopy coverage equals or exceeds 2.8% (400 trees per acre with an average canopy area of 3.14 square feet per tree (2-foot diameter of canopy) is 2.8% of an acre)
 - At Year 6, projects must show canopy coverage equals or exceeds 11.5% (400 trees per acre with an average canopy area of 12.56 square feet per tree (4-foot diameter of canopy) is 11.5% of an acre)
 - At Year 14, projects must show canopy coverage equals or exceeds 46% (400 trees per acre with an average canopy area of 50 square feet per tree (8-foot diameter of canopy) is 46% of an acre)

Note: if projects exceed these progress requirements, they will not receive credits early or out of schedule. If projects fail to meet the progress requirements, they will not be eligible to request credits until they meet the progress requirements.

At Year 26:

- Project Operators must either conduct a physical tree count using plots or use imaging to determine canopy coverage at Year 26. Project Operator provides images of the Project Area from any telemetry, imaging, remote sensing, i-Tree Canopy, or UAV service, such as Google Earth and estimate the area in tree canopy cover (acres). If the canopy coverage equals 100% of the Project Area at the project outset, the credits projected may be issued.
 - Imaging from Google Earth with leaf-on may be used. Project operators will calculate the percent of canopy cover from the Google Earth imaging
 - Projects can use i-Tree Canopy and point sampling to calculate canopy cover. Using i-Tree Canopy, continue adding points until the standard error of the estimate for both the tree and non-tree cover is less than 5%. i-Tree Canopy will supply you with the standard errors.
 - If tree canopy cover is determined using another approach, such as image classification, a short description of the approach should be provided, as well as the QA/QC measures that were used. A tree cover classification accuracy assessment should be conducted, as with randomly placed points, and the percentage tree cover classification accuracy reported.
- Project Operator calculates total CO₂ storage at end of Year 25 as follows:
 - Multiply the CI (supplied by CFC) times the TC (Tree Canopy Cover in acres)
 - Deduct the number of Credits already issued
 - Result is the number of credits to be issued to the project, minus the 5% hold-back for the reversal pool
 - After third-party verification, CFC issues credits per the verification report and the protocol

Background Notes:

- Canopy plantings do not track tree loss because they are ecological projects seeking canopy. Canopy plantings anticipate relatively high tree loss compared to single tree or street-tree type plantings.
- Canopy is generated by the recruitment of species on the site and by planting a variety of smaller and larger species that provide canopy quickly. Larger species that out-compete others provide longer-term canopy coverage.
- Because of the above, the precise number of trees planted is not the key to a successful canopy project. That success often relies on recruitment and the competition of species that enable the success of some trees at the expense of others.

iTree Canopy Formula References

References

i-Tree Canopy Technical Notes

This tool is designed to allow users to easily and accurately estimate tree and other cover classes (e.g., grass, building, roads, etc.) within their city or any area they like. This tool randomly lays points (number determined by the user) onto Google Earth imagery and the user then classifies what cover class each point falls upon. The user can define any cover classes that they like and the program will show estimation results throughout the interpretation process. Point data and results can be exported for use in other programs if desired.

There are three steps to this analysis:

1. Import a file that delimits the boundary of your area of analysis (e.g., city boundary). Some standard boundary files for the US can be located on the US Census website. Data from these sites will require some minor processing in GIS software to select and export a specific boundary area polygon.
2. Name the cover classes you want to classify (e.g., tree, grass, building). Tree and Non-Tree are the default classes given, but can be easily changed.
3. Start classifying each point: points will be located randomly within your boundary file. For each point, the user selects from a dropdown list the class from step 2 that the point falls upon. The more points that are interpreted, the more accurate the estimate.

Credits

The concept and prototype of this program were developed by David J. Nowak, Jeffrey T. Walton and Eric J. Greenfield (USDA Forest Service). The current version of this program was developed and adapted to i-Tree by David Ellingsworth, Mike Binkley, and Scott Maco (The Davey Tree Expert Company).

Limitations

The accuracy of the analysis depends upon the ability of the user to correctly classify each point into its correct class. Thus the classes that are chosen for analysis must be able to be interpreted from an aerial image. As the number of points increase, the precision of the estimate will increase as the standard error of the estimate will decrease. If too few points are classified, the standard error will be too high to have any real certainty of the estimate. Information on calculating standard errors can be found below. Another limitation of this process is that the Google imagery may be difficult to interpret in all areas due to relatively poor image resolution (e.g., image pixel size), environmental factors, or poor image quality.

Calculating Standard Error and Confidence Intervals from Photo-Interpreted Estimates of Tree Cover

In photo-interpretation, randomly selected points are laid over aerial imagery and an interpreter classifies each point into a cover class (e.g., tree, building, water). i-Tree v4 / i-Tree Canopy v1 www.itreetools.org 2/14/2011 From this classification of points, a statistical estimate of the amount or percent cover in each cover class can be calculated along with an estimate of uncertainty of the estimate (standard error (SE)). To illustrate how this is done, let us assume 1,000 points have been interpreted and classified within a city as either "tree" or "non-tree" as a means to ascertain the tree cover within that city, and 330 points were classified as "tree".

To calculate the percent tree cover and SE, let:

N = total number of sampled points (i.e., 1,000)

n = total number of points classified as tree (i.e., 330), and

p = n/N (i.e., 330/1,000 = 0.33)

q = 1 - p (i.e., 1 - 0.33 = 0.67)

SE = $\sqrt{(pq/N)}$ (i.e., $\sqrt{(0.33 \times 0.67 / 1,000)} = 0.0149$)

Thus in this example, tree cover in the city is estimated at 33% with a SE of 1.5%. Based on the SE formula, SE is greatest when p=0.5 and least when p is very small or very large (Table 1).

Table 1. Estimate of SE

(N = 1000) with varying p.

p | SE

0.01 | 0.0031

0.10 | 0.0095

0.30 | 0.0145

0.50 | 0.0158

0.70 | 0.0145

0.90 | 0.0095

0.99 | 0.0031

Confidence Interval

In the case above, a 95% confidence interval can be calculated. "Under simple random sampling, a 95% confidence interval procedure has the interpretation that for 95% of the possible samples of size n, the interval covers the true value of the population mean" (Thompson 2002). The 95% confidence interval for the above example is between 30.1% and 35.9%. To calculate a 95% confidence interval (if N>=30) the SE x 1.96 (i.e., 0.0149 x 1.96 = 0.029) is added to and subtracted from the estimate (i.e., 0.33) to obtain the confidence interval.

SE if n < 10

If the number of points classified in a category (n) is less than 10, a different SE formula (Poisson) should be used as the normal approximation cannot be relied upon with a small sample size (<10) (Hodges and Lehmann, 1964). In this case: SE = $(\sqrt{n}) / N$ For example, if n = 5 and N = 1000, p = n/N (i.e., 5/1,000 = 0.005) and SE = $\sqrt{5} / 1000 = 0.0022$. Thus the tree cover estimate would be 0.5% with a SE of 0.22%.

References

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- Thompson, S. K. 2002. Sampling, second edition. John Wiley and Sons, Inc., New York, New York.

Information Source: <https://help.itreetools.org/canopy/references?embed=true>